Civil Air Patrol
US Air Force Auxiliary

Florida Wing Headquarters

Aerospace Education Briefing

Subject: Water Bottle Rocketry
Initiated By: Maj Linda Trimpey, External AE Officer
Directed To: All AE Members

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Water Bottle Rocketry Briefing

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Jena L. McGovern, C/2d Lt, CAP
SER-FL-315
Citrus County Cadet Squadron

SAFETY NOTE

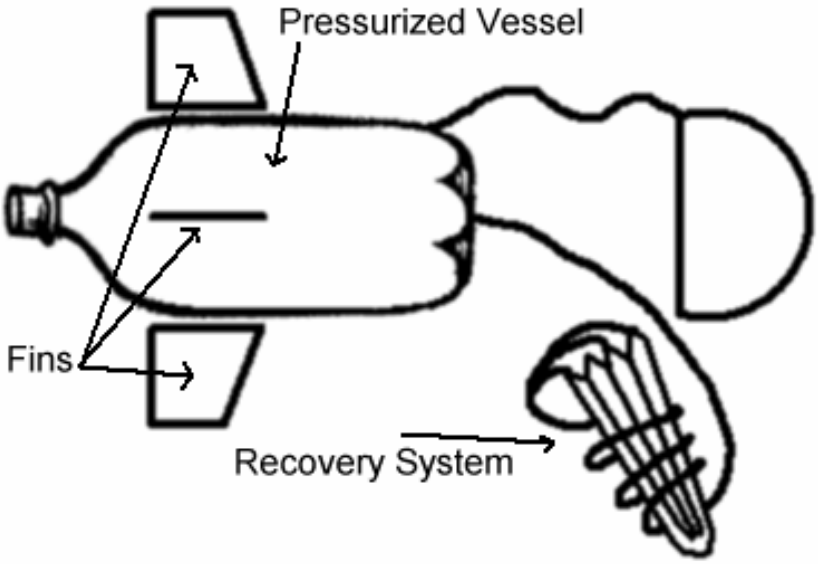
Civil Air Patrol Safety Pledge

I pledge to do my part to foster a safe environment during all CAP activities, to be a responsible steward of CAP resources and to fully prepare myself for the challenging missions that serve America.

Throughout this document, you will find safety notes. It is imperative for your own safety, and the safety of those around you, that you heed these warnings and notes.

Basic Bottle Rocket

The basic water bottle rocket consists of four main components: The pressurized vessel and your method of guidance (eg. the fins), the nose cone, and your recovery system. There are many different kinds of recovery systems. The one illustrated here is a parachute recovery system.



Pressurized Vessel

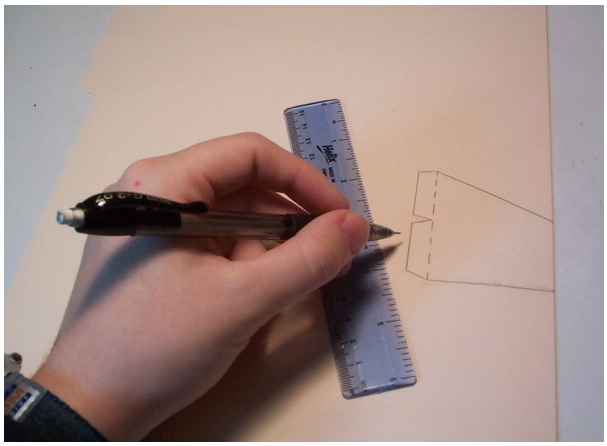
The pressurized vessel is simply the bottle that you will be pressurizing to launch your rocket. This can be anything from a 2 liter bottle down to a 13 oz. bottle. 1 liter bottles tend to be the easier to handle.

Warning: Never compromise the structural integrity of your pressurized vessel. This includes sanding, scratching, cutting, melting, or applying chemical substances to the plastic. Harmful substances include things like super glue, and hot glue. In addition, a rocket should not be launched using the same vessel any more than 4 times maximum; with each launch the vessel is weakened, and there is a greater risk of it exploding and harming you or those around you. Be sure that your pressurized vessel was made to contain carbonated sodas. Non-pressurized vessels, like water bottles, are not made to hold pressure, and will explode. Never attach metal of any kind to your rocket vessel.

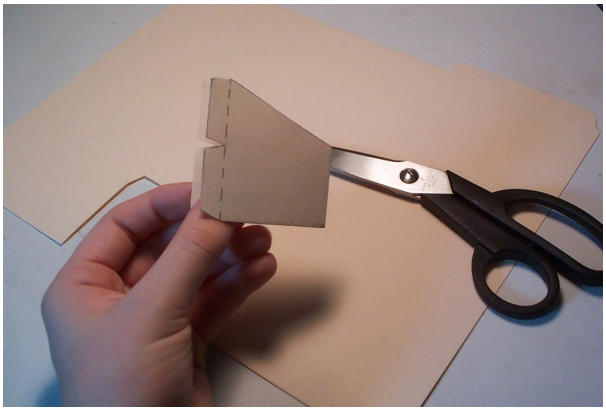
Fins

You fins can be made out of many different substances. It is not advisable to use balsa wood fins because when the vessel is pressurized, the plastic expands, causing the wood to crack and shatter. A good material for a basic fin is thin cardboard or cardstock.

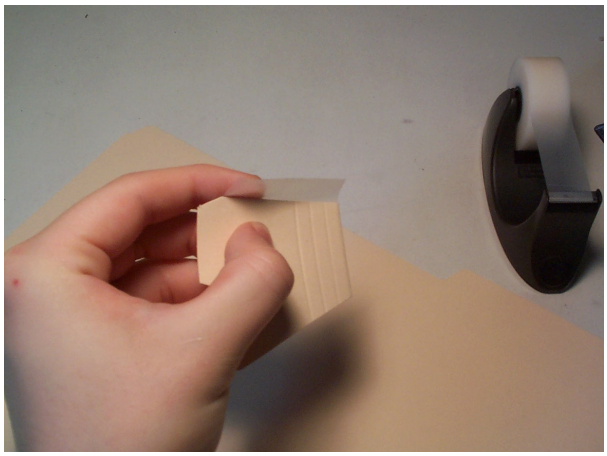
To make this basic fin, use a file folder, pen or pencil, scissors, and tape.



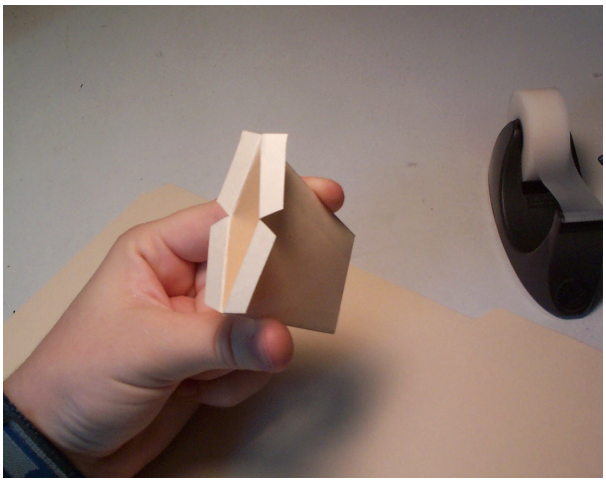
1. On the folded edge of the folder, draw the outline of your fin shape. If desired, you can use this template. Be sure that you use the folded edge of the folder as the outer edge of the fin.



2. Using the scissors carefully cut out the fin pattern from the file folder, and tape two of the sides closed as shown in the picture.



3. You can then fold back the flaps on the open end, and using them, tape the fin to your rocket. Be sure to pre-mark where you are going to put you fins, and put them on straight. Otherwise your rocket will fly crooked.



You can experiment on making your fins with other materials, and find out what works best for your rocket.

Warning: If you use a razor blade or other sharp knife to cut your fins, be sure to use caution, so as to avoid injury.

Nose Cone

There are countless nose cone designs that can be attached to your rocket, but the simplest of them all is the paper cone. All that is involved in making this simple nose cone is twisting stiff paper into a cone shape, trimming, and attaching to your rocket. The following style of nose cone is also rather simple to make.

1. Use a plastic bottle of the same size as your pressurized vessel. Using sharp scissors and/or an X-Acto™ knife, cut the bottle at the shoulder. The top section of the bottle will now form your cone.

2. You can attach it by simply fitting the open end of the cone over the end of your pressurized vessel snugly, or tape it in place if you want.

Warning: Do not attach metal, spikes, or other projectiles to the cone. This can cause injury to the ground crew upon decent.

Recovery

The objective of the recovery system is to bring your rocket down with as minimal structural damage as possible. Without a recovery system, the chances of it going up and then plummeting down to earth unharmed are slim to none. You can experiment with and try out the many different types of recovery systems. Two of the more common ones are the Parachute and the Backslider.

Parachute

The parachute recovery system is probably the simplest recovery method. The greatest challenge with any parachute recovery system is getting the parachute to deploy consistently at apogee. Because of this, several solutions have been developed. The simplest of these is a passive deployment system. This system relies on the fact that the rocket tips at apogee, causing the cone to fall off. In order for this to work, the cone fits loosely, and is supported by tabs, which prevent it from being forced down too much at take-off. The tipping of the rocket at apogee separates the cone from the body of the rocket. The next challenge is getting the parachute out. With parachutes getting larger and larger, many people are now using drogue chutes as a means of opening the main parachute. A drogue chute is simply a smaller parachute, attached to the main. Many people also use talc powder as a technique of lubricating the parachute so that it doesn't stick. This allows it to leave the cone with less friction. (It also makes a cool white cloud if you use enough.)

Backslider

Backsliding rockets do exactly what their name implies. They are modified so that, instead of flipping over and heading nose-down at apogee, they float back down to the ground in a high drag configuration rather than a nose dive. A true backslider will fall straight down in a horizontal position, without tipping from the point of apogee to the point it hits the ground. This results in minimal damage to the rocket, and has produced some very high sustained flight times.

You can create a backsliding rocket by taking an aerodynamically stable rocket, and moving the CG (Center of Gravity) back closer to the CP (Center of Pressure). This prevents it from going into a nose dive at the point of apogee. You can manipulate the CG and CP by adding or taking weight [pennies, clay, washers, etc., attached with tape to the top(s) – inverted bottoms - of the bottle(s) under the nose cone] away from the nose or tail of the rocket, and lengthening the rocket by adding more bottles. It may take multiple tries to get it just right.

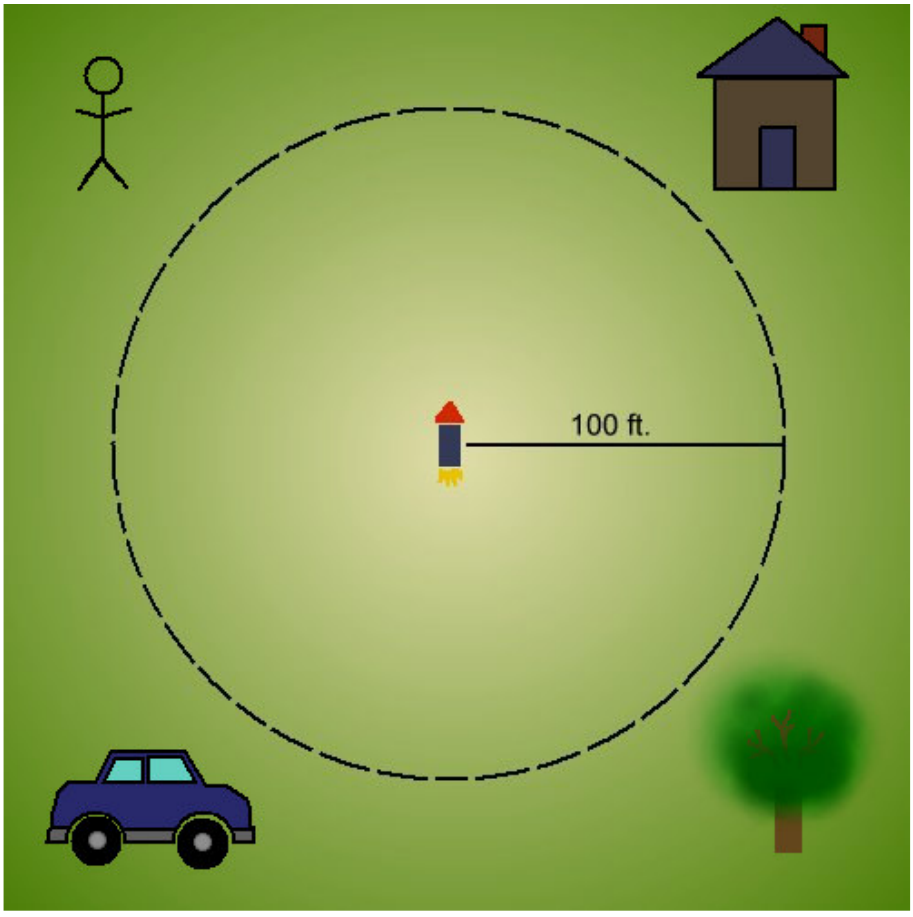
Many competitions do not allow for parachute recovery which makes the backslider my preferred alternate method of recovery.

You can see videos of backslider launches and recoveries here:
http://waterrocket.uh-lab.de/lr011101_backglider_video.htm

Launching

In the excitement of launching your rocket, it is easy to forget that launch is the most dangerous part of bottle rocketry, and demands the most attention and caution, starting with your launch site.

Your launch site should have at least a 100 ft. clearance on all sides, and be away from buildings, vehicles, and trees. The force of a rocket coming down in a nose dive from 100 ft is enough to shatter a window or injure a bystander who isn't paying attention. (Take it from someone who knows.) An uncontrolled rocket can quickly become a ballistic missile. An ideal launch location is an open field or large empty parking lot.



(Note: The launcher shown is the PITSCO Backyard Blaster, but the directions can be applied to most standard launchers. The Backyard Blaster is my preferred launcher because of its simplicity, stability, ease of use, and price. It can be found here: http://www.shop-pitsco.com/pitsco3/catalog.cfm?dest=itempg&itemid=289&secid=23&linkon=category&linkid=56)

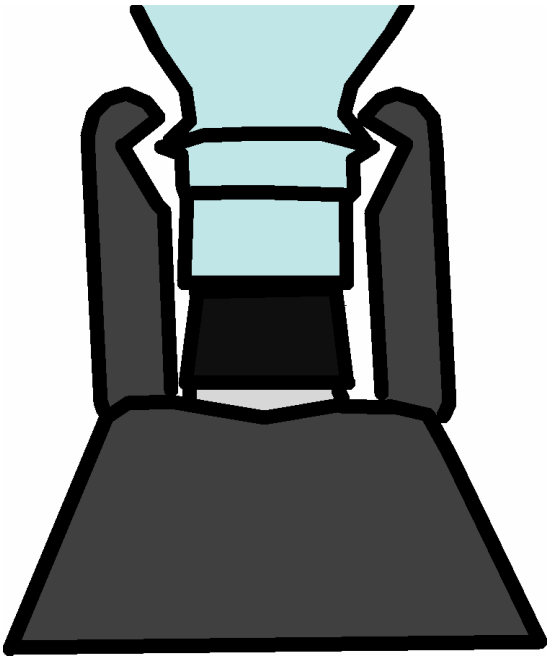
To attach the bottle rocket to the launcher:

1. Put 400-600 ml of water in the bottom bottle of the rocket, turn the bottle nozzle-up, and insert the rubber cork snugly into the mouth of the bottle. It should be tight enough that pressure will not escape, but not so tight that the bottle does not release when the launching pin is pulled.

2. Position it flush against the launcher, close the claws, and insert the launch pin.

Warning: Before pressurizing the rocket, you should double check that it is securely positioned on the launcher. Not being secured properly can cause it to launch prematurely, and potentially injure someone near it.

Illustrated to the right is the correct positioning of the claws. The rocket should not be loose or free to move on the launcher.

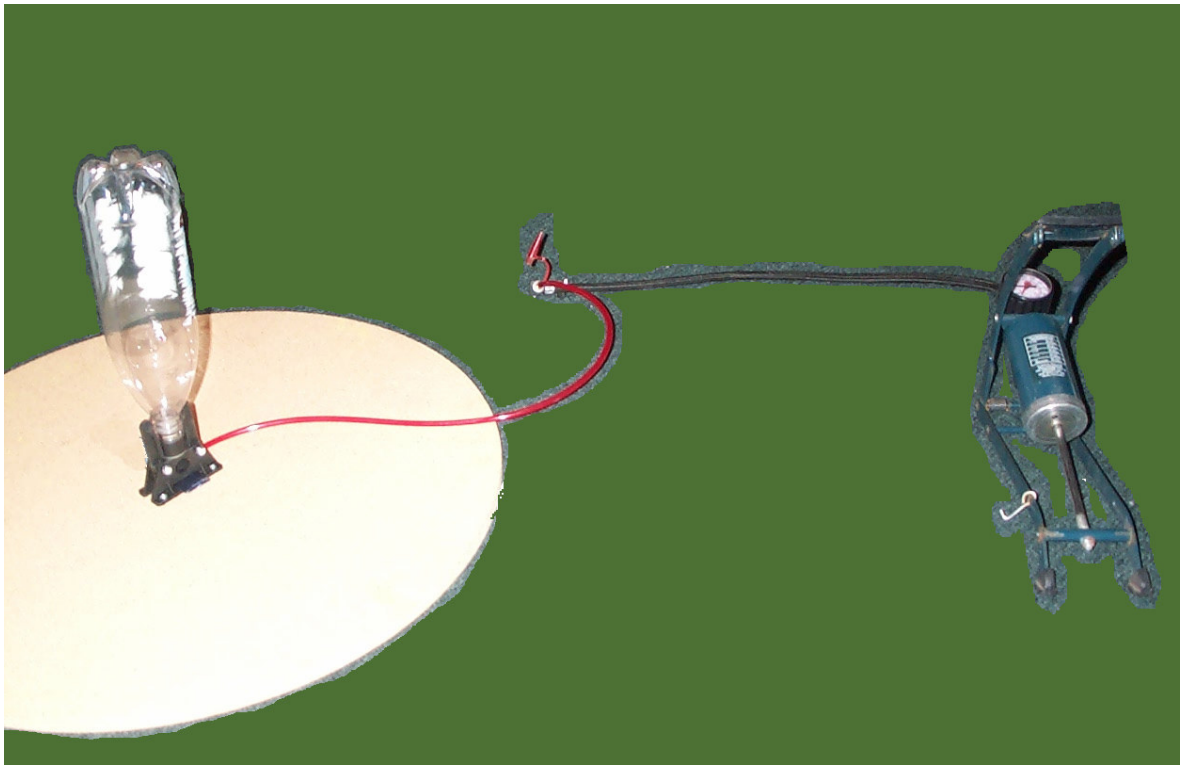


Warning: If your rocket has a skirt around the bottom, be sure that it doesn't interfere with the operation of the launcher.

Pressurizing

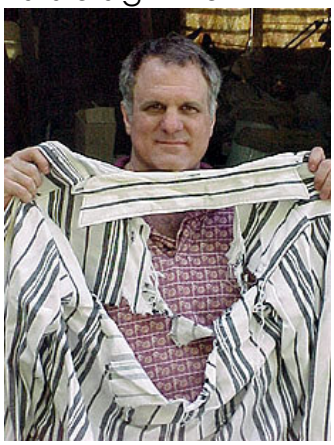
Before pressurizing your rocket, be sure that your bicycle pump's pressure gauge is working. You can do this by testing it on a basketball or playground ball. Once you are sure it is working, you

can hook it up to your launcher and begin pressurizing the rocket by simply pumping it up the way you would a basketball. A good pressure is 60 PSI or under. I wouldn't advise going too much over that because certain pressure vessels can't take that much pressure. When pressurizing the rocket, have the pump as far from the rocket as possible, without pulling at all, and be careful not to lean over the rocket.



Warning: Always wear safety goggles from the point where you attach the rocket to the launcher, to the point when you recover it after launch.

While you are pressurizing the rocket, if you notice that the needle on the pump isn't moving, get as far away from the rocket as you can, as quickly as you can. This is a sign that the bottle has been weakened, and may explode. How much damage can an exploding bottle rocket do? It's just air and water after all, right? Wrong. These photos were taken by a gentleman who had a rocket explode. As



you can see, it tore to pieces the shirt he threw over it. Just imagine what it could do to your face or arms.

Once a rocket is pressurized, do not approach it, lean over it, or handle it. If it fails to launch, treat it with caution when recovering it. Just as you would with rockets using a combustion engine, wait for 60-120 seconds, and then carefully approach the rocket. Keep in mind that it is still pressurized, and can go off at any time.

Launch

When the time comes to launch, clear spectators from the launch area; launcher should retreat to a safe distance of 15-25 ft from the rocket before beginning the launch sequence. Proceed with a loud clear launch count down, and then pull the launch cord. Your rocketry program will probably have its own sequence of events leading up to launch, so definitely go by whatever those are. Keep in mind, though, the number one key that cannot be overstressed is safety.

References

There are tons of other things you can try out with your rockets, from fin types, to recovery systems. Don't be afraid to do more research on your own and experiment. You won't be disappointed. There is practically no limit to what you can achieve when it comes to bottle rockets. You can access some of these websites for more information on bottle rockets and different types of recovery systems. Another way you can access more information on your own is by using internet search engines.

Search Engines –

- www.google.com
- www.yahoo.com
- www.altavista.com
- www.lycos.com

Sites –

- http://ourworld.compuserve.com/homepages/pagrosse/h2oRocketIndex.htm
- http://www.et.byu.edu/~wheeler/benchtop/
- http://waterrocket.uh-lab.de/backglide.htm
- http://www.h2orocket.com

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- Explosion pictures: http://www.h2orocket.com/topic/explode/explode.html